



QuikScat Lesson Learned



Georg Siebes (Group Supervisor, JPL)

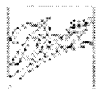
Patrick Wu (Thermal Engr, JPL)

Eric Kelly (Thermal Engr, Ball Aerospace)

Larry Chan (Thermal Engr, ASL)

11th annual Spacecraft Thermal Control Technology Workshop

March 1-3, 2000





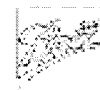
Agenda



- **QuikScat Overview**
- **Science Product**
- **Partners**
- **Job Challenges**
- **Lessons Learned**
 - technical
 - people
 - unexpected
 - post launch
- **Conclusion**



3/3/2000





QuikScat Spacecraft



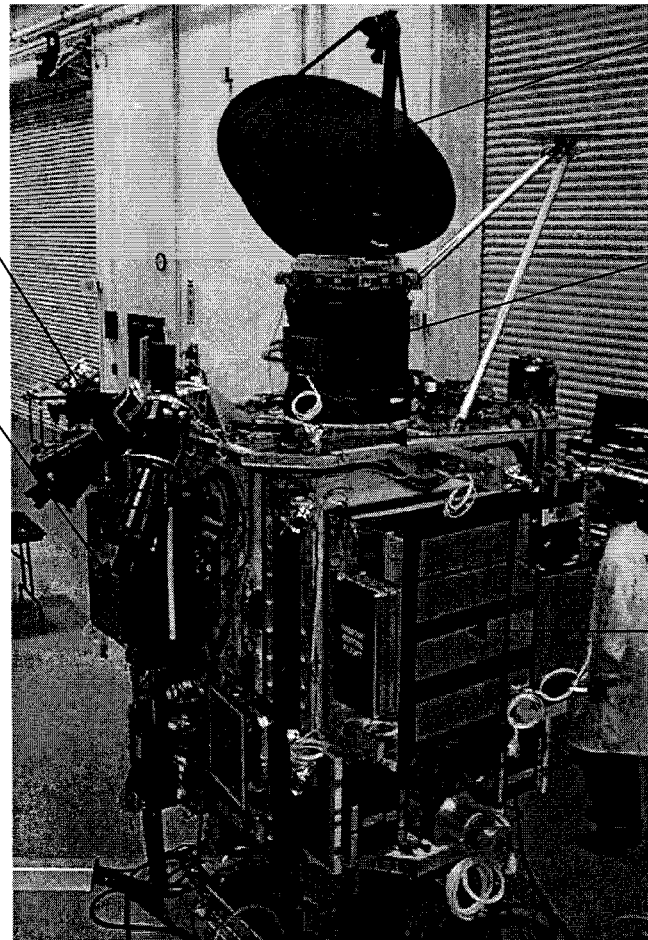
Star tracker

Computing & Data
System (CDS)

The SeaWinds on QuikScat mission is a "quick recovery" mission to fill the gap created by the loss of data from the NASA Scatterometer (NSCAT), when the satellite it was flying on lost power in June 1997.

JPL

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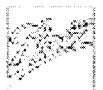


Spinning
Antenna

Scatterometer
Antenna
Subsystem
(SAS)

Spacecraft
Main Bus

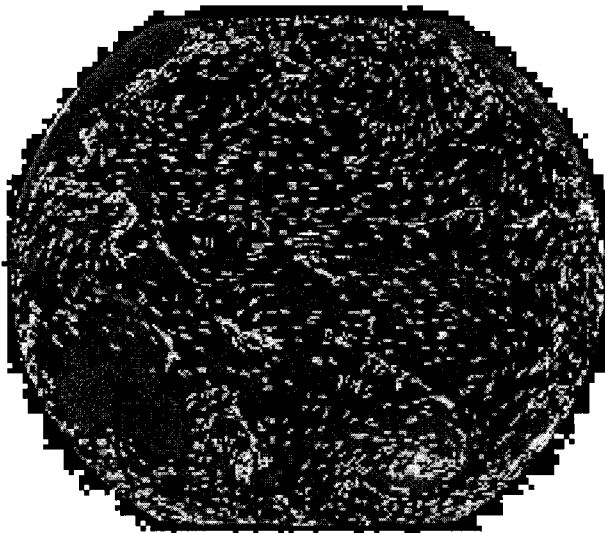
Scatterometer
Electronics
Subsystem
(SES)



Q/S Lessons Learned



Science Product

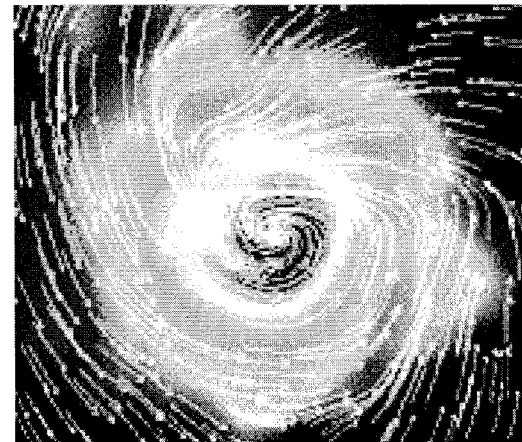


QuikScat acquires all-weather, high-resolution measurements of near-surface winds over global oceans. These measurements improve atmospheric models, weather forecasting, storm warning, ice edge movement, etc...

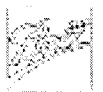
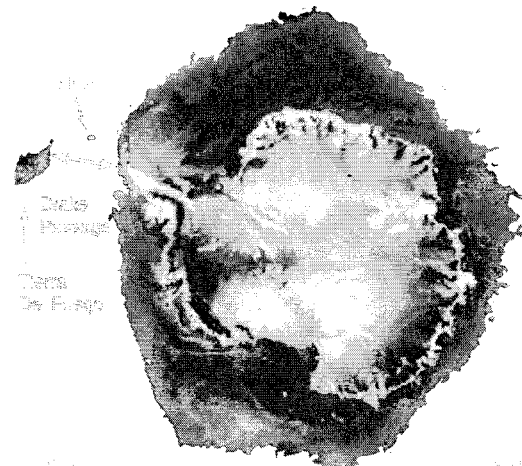
<http://winds/missions/quikscat/quikindex.html>

JPL

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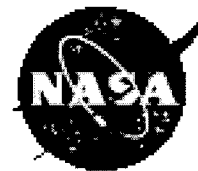


Hurricanes





Partners



- **GSFC - programmatic management**
 - First time implementation of NASA's Indefinite Delivery/Indefinite Quantity program for rapid delivery of satellite core systems
- **BALL Aerospace- spacecraft provider and I&T**
- **LASP (University of Colorado at Boulder) - Mission Operation**
- **JPL - instrument provider and project management**
- **Other contractors and vendors**
 - (Honeywell @ Arizona, E-systems @ Florida and COI @ California) to collaborate for a successful launch from Vandenberg AFB on June 19, 1999





Job Challenges



■ Technical

- launch one year from start
- instrument hardware designed for a different spacecraft - ADEOS II
 - different thermal environments: Beta angles of 58 to 90 vs 12 to 30
 - different physical locations: Nadir deck vs +X, +Y & +Z
 - different bus voltage 46 Volts vs 28 Volts

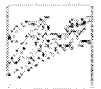




Job Challenges



-
- **Interpersonal**
 - **Immediate team building**
 - numerous interchange meetings
 - coherent working environments
 - success oriented approach with little room for errors





Types of Lessons Learned



■ Technical

- interfaces, resources, schedule

■ People

- commitment, acceptance, trust, decision making

■ What worked and what didn't work

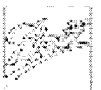




Technical Lessons Learned



- **The dominant constrain was schedule**
 - time spend on minimizing budget was a waste of schedule
 - competence saves time, get the “A-Team”
- **Seek system wide solutions**
 - sub-optimization may cause problems elsewhere
 - holding resources and margin locally makes somebody else’s live more difficult
- **Work being conscious of the impact that your design has on others**
- **Work in anticipation of what comes next**





Technical Lessons Learned



- **Cursory evaluation of min/max beta angles was not adequate.**
- **Needed to survey worst case seasonal conditions (e.g., SES worst hot at beta=64 deg).**
- **Needed to identify worst case condition for each subsystem individually (accounting for different orientation).**
- **Don't mount temperature sensors on heater boards.**





People Lessons Learned



-
- first we built a team, then we built a spacecraft
 - we cared for each other
 - respect
 - trust
 - enjoy cooperation
 - competence
 - reliability
 - communication
 - person to person interaction (travel)
 - sense of humor



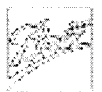


Unexpected Lessons Learned



■ Expectation vs Requirements

- exists
- better to clarify before launch instead of 2 am in the morning after launch
- explain your design and guide expectations
- maintain communication between the design team and the science/project team to ensure common expectations





Unexpected Lessons Learned



- **About 2 WM worth of post launch analysis was performed. The two issues were temperature and temperature stability.**
- **Temperature**
 - **All instrument temperatures were within flight allowables (also within 5C of predictions).**
 - **Worst case predicts were not sufficient. Seasonal behavior was requested. Trend to more “resolution” in the analysis.**



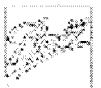


Post Launch Lessons Learned



■ Temperature (cont.)

- Solar panel segments nearest critical SES radiator were turned off causing a warmer thermal environment. Insufficient communication between power and thermal subsystem.
- We are currently flying with solar arrays tilted by 30 deg (away from radiator) to reduce SES temperatures to more acceptable levels.



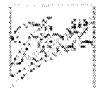


Post Launch Lessons Learned



■ Stability

- Temperature stability was defined as a design goal of 5C per orbit.
- Worst peak-to-peak variation is 7C, 2C higher than the goal.
- Because of long term reliability concerns much analysis was spend on more detailed understanding.
- Expected a value close to 0C at beta = 90deg but measured 1.2C.
- Need to take variable albedo and planet IR into account.



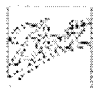


Post Launch Lessons Learned



■ Applicability of Requirements

- Define where the requirements apply. Be specific about the location and instrument/nodalize accordingly.
- Be explicit about the difference between system level requirements versus sub-system/assembly performance.

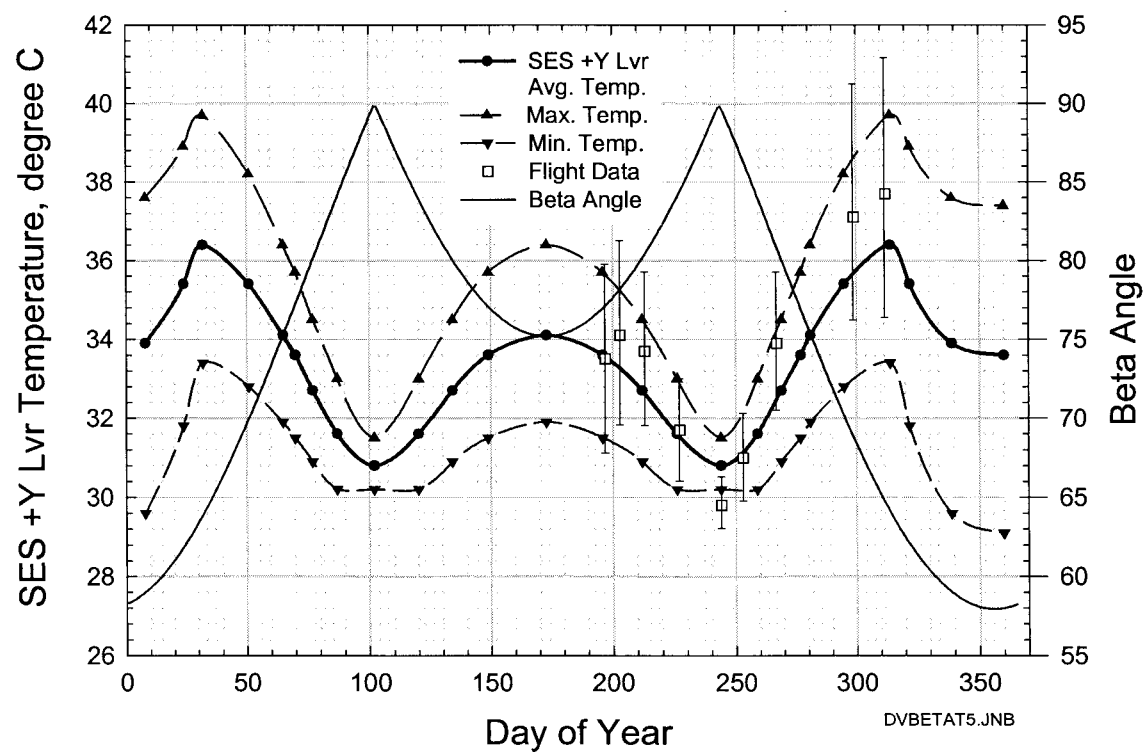




Picture of annual cycle



Figure 9. QuikSCAT Nominal Case SES +Y Lvr Temperatures and Beta Angle Variation with Day of Year in 1999

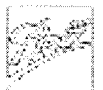


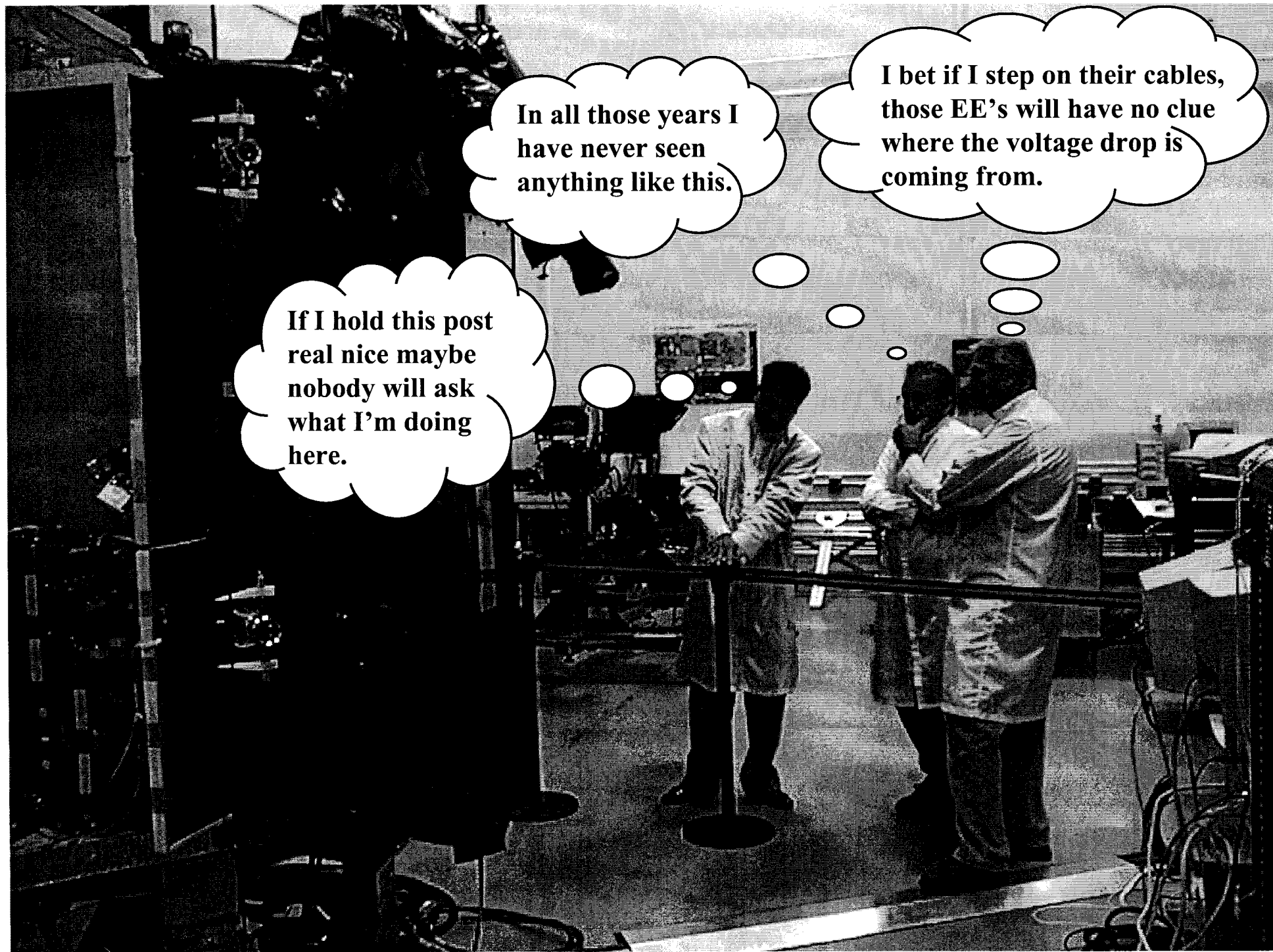


Conclusions



-
- **Enormous accomplishments can be made when**
 - **competent people form a real team**
 - **authority to make decisions is commensurate with the level of responsibility**
 - **bureaucracy and budget doesn't constrain engineering**
 - **people are given the opportunity to interact in person (adequate travel budget)**
 - **everybody enjoys his/her work**
 - **YOU HAVE A TEAM LIKE THIS →**





If I hold this post
real nice maybe
nobody will ask
what I'm doing
here.

In all those years I
have never seen
anything like this.

I bet if I step on their cables,
those EE's will have no clue
where the voltage drop is
coming from.